

Cleidocervical muscle: a mini literature survey of a human muscle variation

S. Silawal, V. Franke, J. Wehrmann, G. Schulze-Tanzil

Institute of Anatomy and Cell Biology, Paracelsus Medical University, Nuremberg and Salzburg, General Hospital Nuremberg, Nuremberg, Germany

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Cleidocervical muscles (CCM) or levator clavicularae muscles in humans can be found as supernumerary unilaterally or bilaterally on the neck attached proximally to the clavicle and distally to the transverse process of cervical vertebrae at various levels. Altogether 20 case reports from year 1994 till present including 25 subjects related to CCM were found and analysed where parameters such as cervical insertion level, clavicular insertion at the middle vs. lateral third, unilateral vs. bilateral presence of the muscle, study type, reported gender of the subjects were extracted. Our literature survey shows that the prevalence of CCM in male and female was equally presented in radiological studies whereas almost 3-fold higher prevalence of males was found in cadaver reports. Since body donor system worldwide is male dominant, a 1:1 proportion of male and female in radiological studies could show more reality-based distribution of this muscle. Nevertheless, the presentation of this muscle was found in over 90% of the case reports unilaterally with higher left sided dominance. Even though the attachment points of CCM varied from case to case, the proximal attachment was found slightly more frequent on the middle third of the clavicle whereas the distal insertion was present more often on the superior cervical vertebrae than the lower ones. With prevalence of CCM in the population around 2.0–2.5%, the clinical, radiological and surgical relevance of this variation has to be highlighted to avoid potential misleading diagnostics in the neck. (Folia Morphol 2023; 82, 3: 513–518)

Key words: cleidocervical, levator clavicularae, cleidoatlanticus, scalene muscles

INTRODUCTION

Cleidocervical muscles (CCM), also termed as levator clavicularae muscles are vestigial muscles in humans which can be found unilaterally or bilaterally on the neck in around 2.0–2.5% of the population [7, 27, 34]. This muscle is attached proximally to the clavicle, runs upwards and crosses obliquely the posterior triangle of the neck before traversing underneath the sternocleidomastoid muscle to connect with the transverse

process of the cervical vertebrae (Fig. 1). However, the proximal as well as distal points of their insertion can vary from case to case. For instance, both middle or lateral portions of the clavicle can serve as the attachment of the muscle proximally, whereas it can connect to the transverse process of cervical vertebrae at various levels distally. The muscle, when attached to the upmost cervical vertebra, the atlas, is termed as cleidoatlanticus muscle [12, 25]. On 28th April 1876, Grüber

Address for correspondence: Dr. S. Silawal, Institute of Anatomy and Cell Biology, Paracelsus Medical University, Salzburg and Nuremberg, Prof. Ernst Nathan Str. 1, 90419 Nuremberg, Germany, tel: +49 – (0)911-398-116771, fax: +49 – (0)911-398-6774, e-mail: sandeep.silawal@pmu.ac.at; sandeep.silawal@klinikum-nuernberg.de

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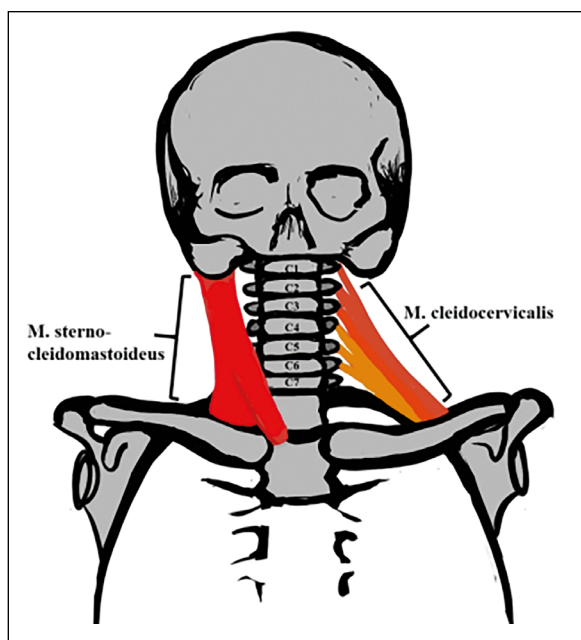


Figure 1. Schematic illustration of the cleidocervical muscle.

[15] dissected the cleidoepistrophicus muscle which connected the anterior tubercle of the transverse process of the axis with the clavicle on the right side of the neck in a male cadaver. Grüber [15] described this muscle as a long, broad and strong muscle slip innervated by the 3rd cervical spinal nerve. Odate et al. [22], reviewed different literatures that have suggested embryological muscle origins related to CCM such as the sternocleidomastoid muscle, trapezius muscle, the anterior scalene and the longus colli muscles. Following different literatures, affiliation to any one of the above origins is a controversial issue. In canines, CCM as well as cleidomastoid muscles are not any muscular variations but integral parts of the brachiocephalicus muscle group originating on the shoulder girdle and inserting on the fibrous raphe of the cranial half of the neck, the skull and on the mastoid process of the temporal bone, respectively [31]. In humans, this vestigial muscle is only found in rare cases, where the muscle is attached deep and medially to the cervical vertebra and extends laterally to the superficial clavicle, forming an irregular triangular space in the posterior triangle of the neck. Underneath this muscle blood vessels, nerves and lymphatics generally pass through to access communication between the upper extremity and the trunk. The presence of this muscle can be symptomatically silent, however, as a predictable result, symptomatic conditions such as thoracic outlet syndrome can be found as reported

in a case study where a 26-year-old male gymnast presented with pain on the right side of his neck, lateral side of right shoulder and right supraclavicular area while lifting heavy objects or arm elevation [3]. As known, a metastatic spread of cancer can lead to an enlargement of the left supraclavicular lymph node, known as the Virchow node [35]. To our context, left sided unilateral presence of this muscle for example could lead to misinterpretation in radiological images as a lymphadenopathy, especially in tumour patients [26, 28]. Therefore, understanding CCM anatomy, their clinical relevance can help radiologists, surgeons as well as clinicians to avoid possible confusion or unnecessary diagnostic measures.

MATERIALS AND METHODS

Literature research related to the CCM variations between year 1990 and 2019 as well as embryological studies were accessed with Medline, Google Scholar as well as ResearchGate using mesh terms such as: CCM variations, levator clavicularae. Parameters such as muscular attachment points, unilaterality/bilaterality of the variation, study type as well as reported gender of the subjects were extracted.

Altogether 20 case reports from year 1994 till 2019 with 25 subjects were analysed in the survey. Some case reports were excluded from the analysis even though they would match according to the searching mesh terms. For example, a muscular variation originated from trapezius and inserted to the clavicle lateral to the sternocleidomastoid was unfortunately termed as levator clavicularae muscle [23]. In terms of historic reports, more appropriate terminology for such variation would be cleidooccipital muscle [34]. Another case report by Bhatnagar and Smith (2021) [4] was also excluded from this analysis, since the superior attachment of this muscle was to the longus capitis muscle fascia rather than to the cervical vertebra itself.

RESULTS

The case reports that we have analysed for this study were based on cadaver research in anatomical dissections as well as on interpretation of radiological images, both 48%. Only a single case was reported as a surgery finding (Fig. 2A). In total subjects from all report types, this survey showed that presence of CCM was slightly more than double fold available in male in comparison to female gender (Fig. 2B). However, if only the radiological reports were considered

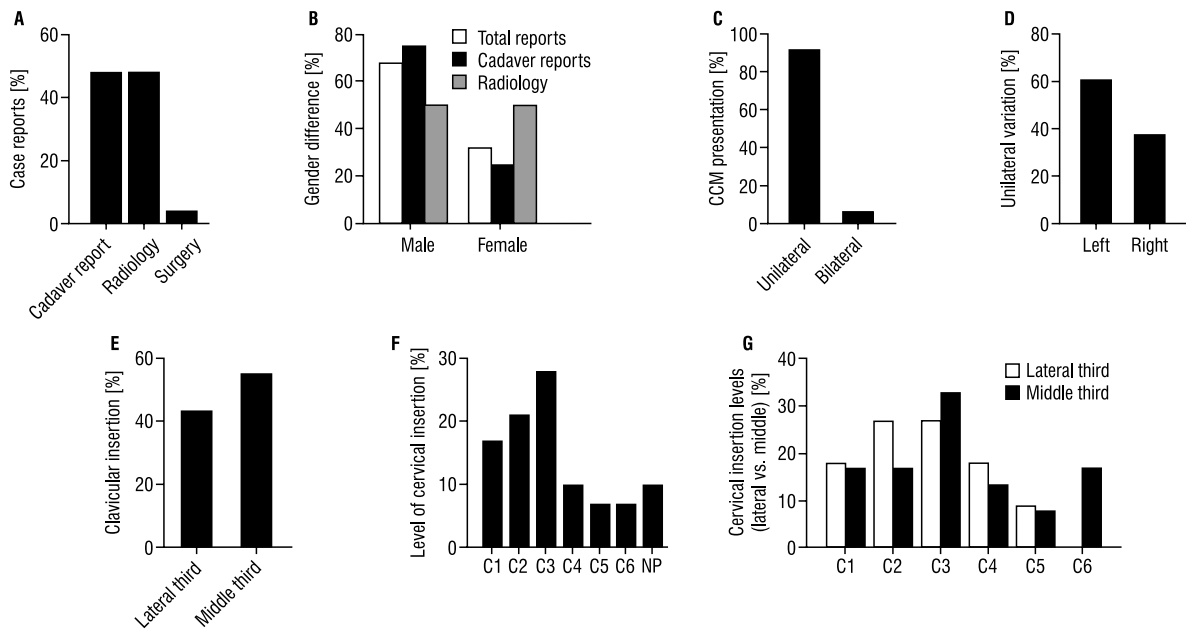


Figure 2. Graphical illustration of various parameters analysed in the literature review from the case reports listed in Table 1; CCM — cleido-cervical muscles; NP — not provided.

for the analysis, the distribution between male and female was equal, i.e. 1:1. In comparison, the cadaver reports showed discrepancy with 3-fold higher male prevalence compared to that in female. Interestingly, CCM was found in 92% of the cases unilaterally (Fig. 2C). However, when present unilaterally, the left sided presentation of the muscle was slightly more frequent than on the right side (Fig. 2D). The proximal attachment of the CCM was found in 56% of the cases on the middle third and 44% on the lateral third of the clavicle (Fig. 2E). Regarding the distal insertion, the attachment of CCM was found mostly at the C1–C3 vertebrae (Fig. 2F). The third cervical vertebra was reported in 28% of the cases as attachment site, followed by the axis with 21% and finally the atlas with 17%. C5 and C6 were the least involved vertebra where respectively 7% of the cases were reported. It has to be considered that in 10% of the case reports, proper description for distal attachments were not provided. If lateral and middle proximal insertions were analysed separately, it showed that the laterally inserted CCM were rather attached more frequently at C2–C3, both 27% whereas no attachment was found on C6 (Fig. 2G). On the other hand, CCM inserted proximally in the middle third of the clavicle showed their most frequent reported distal insertions with 36% at C3. In both of the cases with bilateral presentation, the distal insertions were superior levels of the cervical vertebrae. A tabular illustration for

the above results has been provided below (Table 1) [3, 5, 8, 10–14, 18–22, 24–29, 33].

DISCUSSION

Incidental anatomical findings can be identified in clinical practice during physical examinations, diagnostic imaging or surgical procedures. However, most of the incidental findings regarding anatomical variations are rather reported in cadaver studies [1, 32]. In our literature review, the reported cases were represented in cadaver studies as well as radiological findings equally with 48%, respectively (Fig. 2A). In a historic report of 1870, Wood and Sharpey [34] described CCM to the Royal Society which he discovered 5 years ago in 1864 bilaterally in 2 male subjects. In the same report, Wood and Sharpey [34] noted that CCM was found in altogether 4 males out of 131 (3.05%) and in 1 female out of 71 (1.4%) in a total number of 202 subjects with an average of ca. 2.5%. Hence, the distribution of CCM prevalence between male and female was about 2:1. More than a century later, Rubinstein et al. [27], showed in 1999 the prevalence of 2% in the population analysed using 300 computed tomography-scan images. However, the gender parameter was not considered in their analysis. Our literature review with altogether with 25 subjects displays a double fold prevalence of men in comparison to females of total case reports (Fig. 2B). This shows a very drastic

Table 1. Tabular illustration of case reports

Publications	Cervical insertion	Clavicular insertion	Unilateral		Bilateral	Cadaver report	Radiology	Surgery	Sex	
			Left	Right					Male	Female
Fasel et al., 1994 [10]	NP	L	+				+			+
Tomo et al., 1994 [33]	C6	M	+					+		
Leon et al., 1995 [19]	C2	M		+			+			+
Rüdisili, 1995 [28]	C3	L	+				+			+
Rubinstein et al., 1999 [27]	C1–C3	L(5)/M(2)	++++	+	+		++++++			NP
Ginsberg, Eicher, 1999 [14]	C3	M	+				+			+
Rosenheimer et al., 2000 [26]	C6	M		+			+			+
Ruiz Santiago et al., 2001 [29]	NP	M		+			+			+
Koshy et al., 2005 [18]	C1–C2	L(2)			+	+				+
Aydoğ et al., 2007 [3]	NP	M		+			+			+
Capo, Spinner, 2007 [8]	C2	L	+				+			+
Loukas et al., 2008 [20]	C3–C4	L	+				+			+
Natsis et al., 2009 [21]	C3–C5	L		+			+			+
Rodríguez-Vázquez et al., 2009 [25]	C1	M		+			+			+
Fazliogullari et al., 2010 [11]	C3	M	+				+			+
Feigl, Pixner, 2011 [12]	C1	M		+			+			+
Odate et al., 2012 [22]	C4	M	+				+			+
Raikos et al., 2012 [24]	C3	M	+				+			+
Billings, Sherrill, 2014 [5]	C5	M		+			+			+
Ferrel et al., 2019 [13]	C2–C3	M	+					+		+
Total			14	9	2	12	12	1	13	6

M — median third of a clavicle, L — lateral third of a clavicle; NP — not provided

difference in results depending on which reports was analysed for this study. The explanation could be that a drastic lower number of female cadavers are available for anatomical dissection in many parts of the world in comparison to their male counterparts [30]. In the second half of the 19th century, gender difference in the cadaver subjects reported by Wood and Sharpey [34] showed that almost two-third of the subjects were male. Hence, the distribution of the genders in the cadaveric studies can vary depending on the time period in which the studies were performed as well as socioeconomic, educational status of the donors in the society [2, 17]. A study from Ohio, United States, 1996 showed that even though the cadaveric donors to the donation programme were predominantly male (58%), a clear trend for increasing numbers of females were noted [9]. This clearly

depicts the manner of dynamic changes in above mentioned aspects of our society. Analysing only the radiological reports however, there was an equal distribution between male and female prevalence of this muscle (Fig. 2B). The probable reason could be that the imaging diagnostics are not preferably performed more in males in comparison to females. Hence, we assume that radiological studies could show more reality-based distribution of this muscle at present time.

John Wood wrote that Professor W. Grüber in St. Petersburg, described CCM in year 1847 (Vier Abhandlungen, S. 22), where this muscle was attached from the transverse process of C2 to the middle portion of the clavicle [34]. Grüber [16] cited another right sided variation in a male reported by Kelch et al. in 1813 (Beitrag zur pathologischen Anatomie, Berlin, 1813,

xxiv. S. 32) which could possibly be the oldest recorded description of this muscle. Other descriptions of this muscle by various authors in historic reports have been put together in a review by Odate et al. (2012) [22]. Our analysis comprises reports after 1990 until present day where unilateral CCM presentation was found in over 90% of the studies (Fig. 2C). A unilateral presence of the variance on the neck could probably provoke high attention in a clinical scenario where this muscle could be misinterpreted as pathological case such as lymphadenopathy, metastatic lymph nodes or neoplasms [13, 26]. Left sided presentation of CCM was slightly higher than on the right side (Fig. 2D). Specially, the left sided CCM can be misread as an enlargement of the left supraclavicular Virchow node [35]. The proximal attachments of the muscle were described in all the case reports either on the lateral or on the middle third of the clavicle. But no report has been made so far describing their proximal attachment on the medial third. Slightly more reports with middle third insertion were available so far in comparison to the lateral one (Fig. 2E). However, concerning the cervical attachment C3 level had the highest reference in comparison to other cervical levels (Fig. 2F). In general, the superior cervical levels showed more regular distal attachment than to the inferior ones. Some case reports could not provide accurate cervical attachment level for the muscle, probably due to difficulty in the evaluation of the radiological images [3, 10, 29]. Obviously, anatomical dissections are distinctly more convenient to evaluate the exact insertion points in comparison to radiological or surgical approaches. Figure 2G shows that CCM attached proximally on the lateral third of the clavicle are distally attached to the cervical vertebrae C1–C5 with maximum references to C2/C3 whereas the muscles with middle third attachment of the clavicle are distally attached to C1–C6 with maximum reference at C3. There could be a possible pattern to differentiate if lateral and middle third inserted muscles show their respective cervical insertion in higher and lower cervical levels, respectively. However, more cases have to be available to verify the result significantly. The proximal insertion of middle and anterior scalene in the first rib provides similar anatomy where the middle scalene muscle attaches more laterally on the rib compared to the anterior scalene muscle [6]. Also, comparing the points of distal attachments middle, scalene muscle has broader distribution in the cervical levels in comparison to the

anterior scalene muscle. Therefore, we propose the hypothesis that CCM attached laterally to the clavicle could be a variation derived from the middle scalene muscle whereas the medially attached CCM might derive from the anterior scalene muscle.

CONCLUSIONS

Our literature survey shows that the prevalence of CCM in male and female was equally presented in radiological studies whereas almost 3-fold higher prevalence of males in cadaver reports. The presentation of this muscle was found in over 90% of the case reports unilaterally with higher left sided dominance. The proximal attachment was found slightly more frequent on the middle third of the clavicle whereas the distal insertion was available more often on the superior cervical vertebrae than the lower ones. The clinical, radiological as well as surgical relevance to this variation has to be highlighted to sensitise clinicians or radiologists about the possible presence of CCM in order to avoid potential misleading diagnostics in the future.

Conflict of interest: None declared

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